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(54) **Hydraulic torque impulse mechanism**
Hydraulischer Drehschlagmechanismus
Mécanisme hydraulique rotatif à chocs

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(73) Proprietor: **ATLAS COPCO TOOLS AB**
105 23 Stockholm (SE)

(72) Inventor:
Schoeps, Knut Christian
S-135 47 Tyresö (SE)

(74) Representative: **Pantzar, Tord**
Atlas Copco Tools AB
Patent Department
105 23 Stockholm (SE)

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Description

This invention relates to a hydraulic torque impulse mechanism which is intended for a torque delivering tool and which includes a rotatively driven drive member provided with a concentric fluid chamber as well as a radially acting cam means, an output shaft extending into the drive member fluid chamber and having two radially extending cylinder bores, which communicate continuously with each other via a central high pressure chamber, and two oppositely disposed piston elements reciprocable in the cylinder bores by the cam means.

Impulse mechanisms of the above type, disclosed for example in US-A-5,092,410, are characterized by a very efficient impulse generation, because the high pressure chamber is very small and the fluid entrapped therein at impulse generation is compressed simultaneously from two opposite directions. This makes the pressurized fluid volume very stiff, and because of this high stiffness, the pressure build-up and the retardation of the drive member takes place very abruptly at each impulse generation.

Accordingly, the resulting torque impulses have an extremely steep characteristic. This is a drawback when providing the tool with a torque transducer for producing electric signals reflecting the torque magnitude of the delivered impulses. The very steep impulse characteristics makes it difficult to obtain reliable signals from the torque transducer.

The main object of the invention is to provide an impulse mechanism of the above type comprising a moderating volume with a pressure responsive yielding means for increasing the elasticity of the entrapped pressurized fluid volume, thereby making the pressure build-up in the high pressure chamber less steep. This yielding means is active as the pressure difference between the high pressure chamber and the drive member fluid chamber is below a certain level only.

This object is achieved by providing a hydraulic torque impulse mechanism as defined in claim 1.

Further characteristics and advantages of the invention will appear from the following specification.

A preferred embodiment of the invention is described below in detail with reference to the accompanying drawings.

On the drawings:

Fig 1 shows a longitudinal section through an impulse mechanism according to the invention.

Fig 2 shows, on a larger scale, a fragmentary view of the impulse mechanism in Fig 1.

Fig 3 shows an end view of a piston element.

Fig 4a and 4b show cross sections along line IV-IV in Fig 1, illustrating two different relative positions of the elements of the impulse mechanism.

Fig 5 shows a diagram illustrating the torque impulse characteristic with and without the employment of the invention.

The impulse mechanism shown in the drawing figures is particularly intended for a screw joint tightening tool and comprises a drive member 10 rotatively driven by a motor (not shown) via a rear stub axle 11.

The drive member 10 is formed with a concentric fluid chamber 12 which at its forward end is closed by a threaded annular end wall 13. The latter is provided with an fluid filler plug 14.

The end wall 13 is also formed with a central opening 15 which forms a plain bearing for an output shaft 16. The latter extends by its rear end into the fluid chamber 12 and is formed with a square portion 17 at its forward end for connection to a standard type nut socket. At its inner end, the output shaft 16 is provided with two radially directed cylinder bores 18, 19 which extend coaxially relative to each other. Within these cylinder bores 18, 19 there are movably guided piston elements 20, 21 defining between them a central high pressure chamber 23.

The drive member 10 is provided with a cam means for accomplishing controlled radial reciprocating movements of the piston elements 20, 21 at relative rotation between the drive member 10 and the output shaft 16. The cam means comprises a cam surface 24 with two 180 degrees spaced cam lobes 25, 26 on the cylindrical wall of the fluid chamber 12, and a central cam spindle 28. The latter is connected to the drive member 10 by means of a claw type clutch 29 and extends into a coaxial bore 30 in the output shaft 16. At relative rotation between the drive member 10 and the output shaft 16, the cam lobes 25, 26 on the fluid chamber wall act to urge simultaneously both piston elements 20, 21 inwardly, toward each other. With a 90° phase lag in relation to the cam lobes 25, 26, the cam spindle 28 acts on the piston elements 20, 21 to move the latters outwardly into positions where they again can be activated by the cam lobes 25, 26.

As apparent from Figs 1, 2 and 3, each of the piston elements 20, 21 comprises a cylindrical cup-shaped body and a roller 31 and 32, respectively. The purpose of the rollers 31,32 is to reduce the frictional resistance between the piston element and the cam lobes 25, 26.

The cylinder bores 18, 19 are formed with longitudinal grooves 33, 34 which extend from the outer ends of the bores 18, 19 but do not reach the inner ends of the bores 18, 19. A circular cylindrical seal portion 35 is left for sealing cooperation with a circular seal portion 36 on the piston elements 20, 21. The seal portion 36 is located between outer flat portions 37 and inner flat portions 38 whereby is formed by-pass passages past the seal portion 35 as the seal portion 36 on the piston element 20, 21 is out of register with the seal portion 35. See Fig 2.

In order to lock the piston elements 20, 21 against rotation and to ensure that the flat portions 37, 38 are always aligned with the grooves 33, 34, each roller 32 is formed with an axial extension 40 which is partly received and guided in one of the grooves 34.

For avoiding two torque impulses to be generated during each relative revolution between the drive member 10 and the output shaft 16, the cam spindle 28 is formed with a flat portion 42 which is arranged to open up a communication between the high pressure chamber 23 and the fluid chamber 12 by cooperating once every relative revolution with a radial opening 43 in the output shaft 16. See Fig 1.

Moreover, the output shaft 16 is provided with two each other opposite impulse moderating chambers 45, 46. These chambers 45, 46 are formed by a diametrically extending bore which intersects the cylinder bores 18, 19 as well as the axially extending bore 30. Each one of the chambers 45, 46 is defined by an end closure 47 which is secured to the output shaft 16 by a thread connection 48. The end closure 47 serves as a mounting and support means for a circular steel membrane 50 and is formed with a shallow part-spherical abutment surface 51. A retaining ring 52 is located inside the end closure 47 to clamp the outer rim of the membrane 50 into sealing contact with the surface 51. A central through opening 54 provides a fluid communication between the fluid chamber 12 and the end closure 47 facing side of the membrane 50.

The membrane 50 has a nominal flat circular shape and is elastically deformable by the pressure difference between the high pressure chamber 23 and the surrounding fluid chamber 12. As the pressure difference exceeds a certain level, the membrane 50 is urged into contact with the abutment surface 51, whereby the yielding action of the membrane 50 is limited.

In operation, the drive member 10 receives a driving torque from a motor via the stub axle 11, and the output shaft 16 is connected to a screw joint to be tightened by means of a nut socket attached to the square portion 17.

During the low torque running down phase of the tightening process, the cam lobes 25, 26 are moved from the positions illustrated in Fig 4a to positions in which they start engaging the rollers 31, 32. The seal portions 36 of the pistons 20, 21 start cooperating with the seal portions 35 in the cylinder bores 18, 19. To begin with, the transferred torque is low enough not to generate any real pressure increase in the high pressure chamber 23. Accordingly, the pressure difference between the high pressure chamber 23 and the fluid chamber 12 is not yet high enough to cause any deformation of the membranes 50.

As the screw joint is run down and the pretensioning phase starts, the cam lobes 25, 26 start urging the pistons 20, 21 inwardly, thereby compressing the fluid volume entrapped in the high pressure chamber 23 and the moderating chambers 45, 46. Resulting from the increased pressure in the high pressure chamber 23 and the moderating chambers 45, 46 the membranes 50 yield outwardly, thereby providing an increased elasticity of the entrapped fluid volume. As the pressure in the high pressure chamber 23 reaches a certain level, however, the membranes 50 abut against the surfaces 51, whereby further deformation of the membranes 50 is stopped. The fluid behind the membranes 50 is expelled into the fluid chamber 12 through the openings 54.

As the pistons 20, 21 are moved further inwardly by the cam lobes 25, 26, the seal portions 36 loose their sealing cooperation with the seal portions 35 in the cylinder bores 18, 19, which means that fluid from the high pressure chamber 23 may escape past these seal portions 35, 36 and that the pressure in the high pressure chamber 23 drops rapidly. Consequently, the torque transfer from the drive member 10 to the output shaft 16 is interrupted.

In Fig 5, there is illustrated the transferred torque M in relation to time t during a typical torque impulse.

The dash-line curve illustrates the torque impulse characteristics obtained in a prior art impulse mechanism of the type described in the preamble of claim 1. Characteristic features of this prior art impulse is a very abrupt and steep torque growth during the first part of the impulse and a sharp peak torque before the screw joint starts rotating. Both of these characteristics make it very difficult to obtain reliable signals from a torque transducer fitted to the output shaft. The process is simply too fast and abrupt to be correctly registered by any electronic process control and/or monitoring equipment.

In comparison, the solid line curve illustrates the impulse characteristics of a mechanism employing the features of the invention. As appear from the diagram, the torque growth during the first 2,5 ms (milliseconds) takes place rather slowly due to the yielding action of the membranes 50. At the end of this initial stage, the membranes 50 have reached their fully deformed positions and abut against the surfaces 51 in the end closures 47. This means that the resiliency of the fluid volume entrapped in the high pressure chamber 23 suddenly decreases and that the pressure in the high pressure chamber 23 as well as the transferred torque increase more rapidly.

However, due to the increased volume of the high pressure chamber provided by the additional moderating chambers 45, 46, the torque increase is not at all so steep as for a prior art impulse mechanism. Note the difference in inclination between the solid line curve and the dash-line curve in Fig 5. In the example illustrated in Fig 5, the peak torque is reached in about twice the time of the same impulse phase of a prior art mechanism.

The increased high pressure chamber volume also reduces the peak torque level but extends the impulse duration, which means the same amount of energy is transferred.

The slower torque growth and the less sharp peak torque of the impulses generated by a torque impulse mechanism according to the invention makes it possible to practically use a torque transducer and a process control and/or monitoring equipment.

Claims

1. Hydraulic torque impulse mechanism intended for a torque delivering tool, comprising a rotatively driven drive member (10) provided with a concentric fluid chamber (12) as well as a radially acting cam means (25, 26, 28), an output shaft (16) extending through said drive member fluid chamber (12) and having two radially extending cylinder bores (18, 19) which communicate continuously with a central high pressure chamber (23), and two oppositely disposed piston elements (20, 21) which are reciprocable in said cylinder bores (18, 19) by said cam means (25, 26, 28),
characterized in that said output shaft (16) comprises at least one impulse moderating chamber (45, 46) which communicates continuously with said high pressure chamber (23) to add volume to said high pressure chamber (23), said at least one impulse moderating chamber (45, 46) comprises a pressure responsive wall means (50) which elastically yields, for increasing the elasticity of the pressurized fluid volume in said high pressure chamber (23), as the pressure difference between said high pressure chamber (23) and said drive member fluid chamber (12) is below a certain level only so that, in use of the impulse mechanism, the pressure in the high pressure chamber (23) increases more rapidly after the pressure difference has reached said certain level than that it increases prior to reaching said certain level.

2. Impulse mechanism according to claim 1, wherein said yielding wall means (50) comprises one or more membranes (50) forming part of said at least one impulse moderating chamber (45, 46), each one of said membrane or membranes (50) being supported by a mounting member (47) which comprises an abutment means (51) for limiting the elastic deformation of said membrane (50).

3. Impulse mechanism according to claim 2, wherein said at least one moderating chamber (45, 46) comprises two diametrically opposed compartments (45, 46) formed by a transverse bore extending through said output shaft (16) perpendicularly to said cylinder bores (18, 19) and intersecting said high pressure chamber (23), and said mounting member (47) comprises two end closures (47) confining said compartments (45, 46) formed by said transverse bore.

4. Impulse mechanism according to claim 3, wherein said end closures (47) confine said membrane or membranes (50).

5. Impulse mechanism according to claim 4, wherein each of said membranes (50) has a flat nominal shape, and each of said end closures (47) comprises a part-spherical surface forming said abutment means (51).

Patentansprüche

1. Hydraulischer Drehmomentimpuls-Mechanismus für ein drehmomentabgebendes Werkzeug mit einem drehend angetriebenen Antriebselement (10), das mit einer konzentrischen Fluidkammer (12) und radial wirkenden Nockenmitteln (25, 26, 28) versehen ist, einer Abtriebswelle (16), die sich durch die Fluidkammer (12) des Antriebselements erstreckt und zwei radial verlaufende, zylindrische Bohrungen (18, 19) aufweist, die ständig mit einer zentralen Hochdruckkammer (23) in Verbindung stehen, sowie zwei entgegengesetzt angeordneten Kolbenelementen (20, 21), die durch die Nockenmittel (25, 26, 28) in den zylindrischen Bohrungen (18, 19) hin- und herbewegbar sind, **dadurch gekennzeichnet**, daß die Abtriebswelle (16) wenigstens eine impulsabschwächende Kammer (45, 46) aufweist, die ständig mit der Hochdruckkammer (23) in Verbindung steht, um deren Volumen zu vergrößern, und auf Druck ansprechende Wandmittel (50) aufweist, die dann zur Steigerung der Nachgiebigkeit des unter Druck gesetzten Fluidvolumens in der Hochdruckkammer (23) elastisch nachgeben, wenn die Druckdifferenz zwischen der Hochdruckkammer (23) und der Fluidkammer (12) des Antriebselements unterhalb eines bestimmten Niveaus liegt, so daß im Betrieb des Impulsmechanismus der Druck in der Hochdruckkammer (23), nachdem die Druckdifferenz das bestimmte Niveau erreicht hat, schneller ansteigt als vor dem Erreichen des bestimmten Niveaus.

2. Impulsmechanismus nach Anspruch 1, **dadurch gekennzeichnet**, daß die nachgiebigen Wandmittel (50) eine oder mehrere Membranen (50) besitzen, die einen Teil der wenigstens einen impulsabschwächenden Kammer (45, 46) bilden, wobei jede Membran (50) durch ein Befestigungselement (47) gehalten ist, das Anlagemittel (51) zur Begrenzung der elastischen Verformung der Membran (50) aufweist.

3. Impulsmechanismus nach Anspruch 2, **dadurch gekennzeichnet**, daß die wenigstens eine dämpfende Kammer (45, 46) zwei diametral gegenüberliegende Räume (45, 46) besitzt, die von einer Querbohrung gebildet sind, die sich durch die Abtriebswelle (16) senkrecht zu den zylindrischen Bohrungen (18, 19) erstreckt und die Hochdruckkammer (23) schneidet, und das Befestigungselement (47) zwei Endverschlüsse (47) aufweist, welche die durch die Querbohrung gebildeten

Räume (45, 46) begrenzen.

4. Impulsmechanismus nach Anspruch 3, **dadurch gekennzeichnet**, daß die Endverschlüsse (47) die Membranen (50) begrenzen.

5. Impulsmechanismus nach Anspruch 4, **dadurch gekennzeichnet**, daß jede Membran (50) eine flache Ausgangsform besitzt und jeder Endverschluß (47) eine teilsphärische Oberfläche aufweist, welche die Anlagemittel (51) bildet.

Revendications

1. Mécanisme hydraulique à impulsions de couple destiné à un outil de distribution de couple, comprenant un élément d'entraînement (10) entraîné en rotation et muni d'une chambre à fluide concentrique (12) ainsi que d'un dispositif à cames agissant radialement (25, 26, 28), un arbre de sortie (16) passant à travers la chambre à fluide (12) de l'élément d'entraînement et comportant deux alésages de cylindre s'étendant radialement (18, 19) qui communiquent de façon continue avec une chambre haute pression centrale (23), et deux éléments de piston disposés en opposition (20, 21), qui peuvent aller et venir dans les alésages de cylindre (18, 19) sous l'action du dispositif à cames (25, 26, 28), caractérisé en ce que
l'arbre de sortie (16) comprend au moins une chambre modératrice d'impulsion (45, 46) qui communique de façon continue avec la chambre haute pression (23) pour augmenter le volume de cette chambre haute pression (23), et la chambre modératrice d'impulsion au moins unique (45, 46) comprend un moyen de paroi sensible à la pression (50) qui fléchit élastiquement pour augmenter l'élasticité du volume de fluide pressurisé dans la chambre haute pression (23) dans le cas seulement où la différence de pression entre la chambre haute pression (23) et la chambre à fluide (12) de l'élément d'entraînement, est au-dessous d'un certain niveau, de façon qu'en cours d'utilisation du mécanisme à impulsions, la pression dans la chambre haute pression (23) augmente plus rapidement après que la différence de pression ait atteint le certain niveau ci-dessus, qu'avant que la différence de pression ait atteint ce certain niveau.

2. Mécanisme à impulsions selon la revendication 1, dans lequel
le moyen de paroi à fléchissement souple (50) comprend une ou plusieurs membranes (50) faisant partie de la chambre modératrice d'impulsion au moins unique (45, 46), chacune de ces membranes (50) étant supportée par un élément de montage (47) comprenant un moyen de butée (51) pour limiter la déformation élastique de la membrane (50).

3. Mécanisme à impulsions selon la revendication 2, dans lequel
la chambre modératrice au moins unique (45, 46) comprend deux compartiments diamétralement opposés (45, 46) qui sont formés par un alésage transversal passant à travers l'arbre de sortie (16) perpendiculairement aux alésages de cylindre (18, 19) et coupant la chambre haute pression (23), et l'élément de monture (47) comprend deux fermetures d'extrémité (47) enfermant les compartiments (45, 46) formés par l'alésage transversal.

4. Mécanisme à impulsions selon la revendication 3, dans lequel
les fermetures d'extrémité (47) limitent et emprisonnent la ou les membranes (50).

5. Mécanisme à impulsions selon la revendication 4, dans lequel
chacune des membranes (50) présente une forme nominale plate, et chacune des fermetures d'extrémité (47) comprend une surface partiellement sphérique formant le moyen de butée (51).

FIG 1

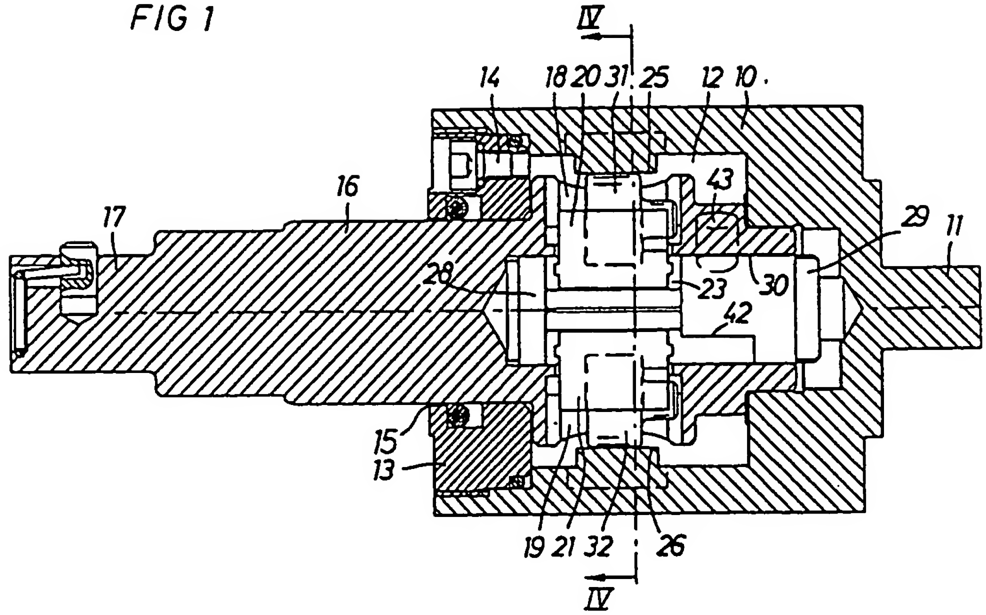

FIG 5

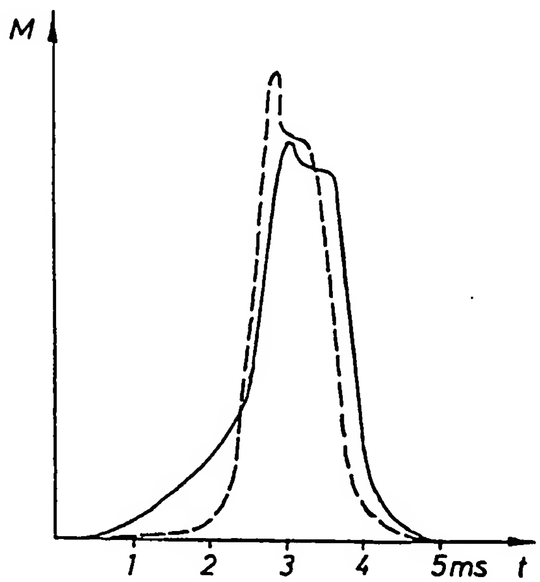

FIG 2

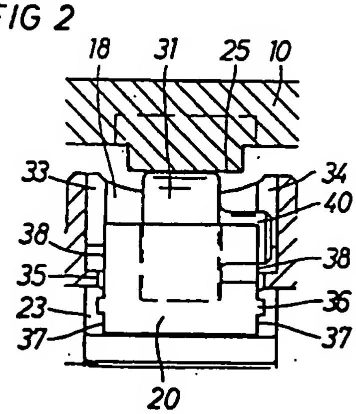

FIG 3

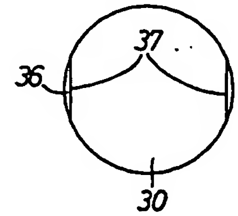

FIG 4a

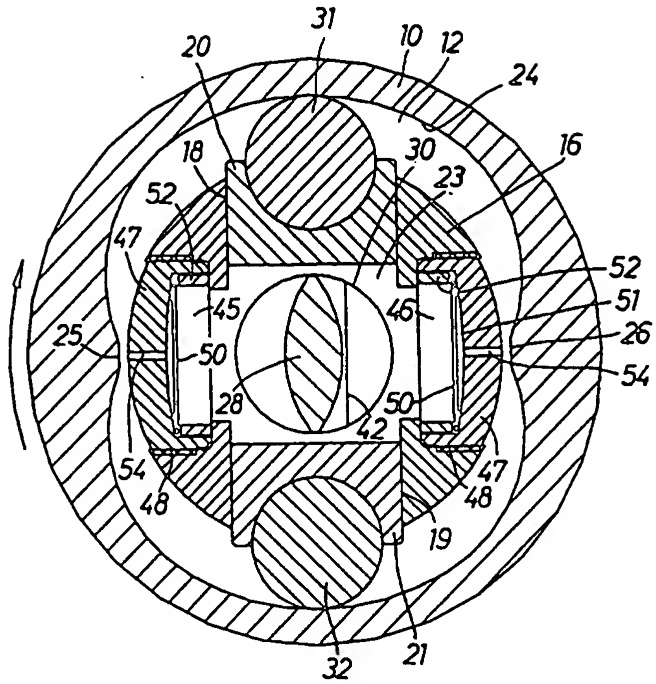
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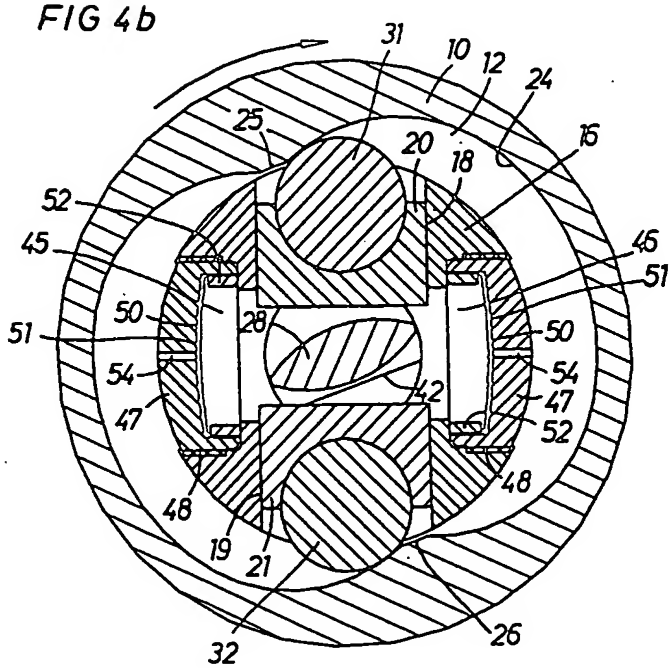
FIG 4b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